25 Rows X 40 Columns

ADDR OFFSET		ROW \ COL	
DEC	HEX	D	H
000	0000	0	0
040	0028	1	1
080	0050	2	2
120	0078	3	3
160	00A0	4	4
200	00C8	5	5
240	00F0	6	6
280	0118	7	7
320	0140	8	8
360	0168	9	9
400	0190	10	A
440	01B8	11	B
480	01E0	12	C
520	0208	13	D
560	0230	14	E
600	0258	15	F
640	0280	16	10
680	02A8	17	11
720	02D0	18	12
760	02F8	19	13
800	0320	20	14
840	0348	21	15
880	0370	22	16
920	0398	23	17
960	03C0	24	18

D	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
H	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27

03E7 → 999

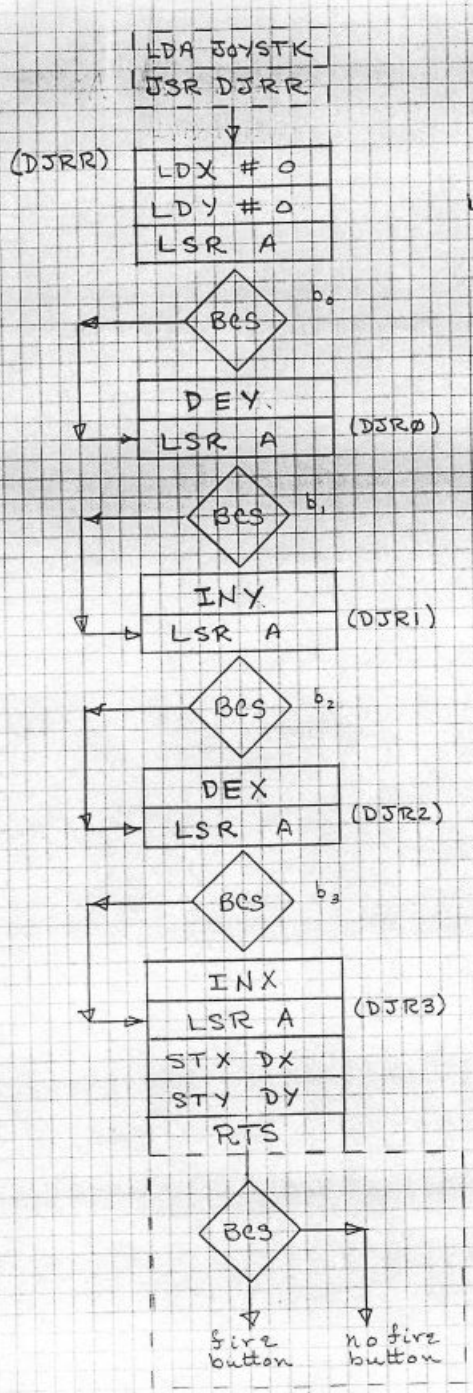
Video Matrix Reference Chart

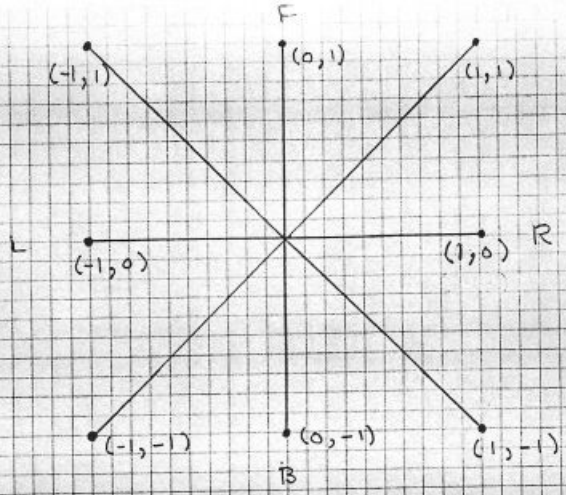
Notes:-

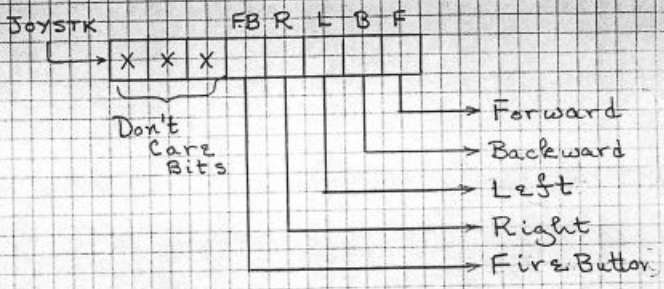
1) The base address in the Max System is $0400 (1024)
2) The sprite pointer address offset is $03F8 (thru $03FF)
3) The base address of the Color Matrix is $D800

```
READY.

1000 .PAGE (JOYSTICK.7/1)  JOYSTICK - BUTTON READ ROUTINE
1005 ;
1006 ;AUTHOR - BILL HINDORFF
1007 ;
1010 DJRR   LDX #0        ;THIS ROUTINE READS AND DECODES THE
1020        LDY #0        ;JOYSTICK/FIREBUTTON INPUT DATA IN
1030        LSR A         ;THE ACCUMULATOR. THIS LEAST SIGNIFICANT
1040        BCS DJR0      ;5 BITS CONTAIN THE SWITCH CLOSURE
1050        DEY           ;INFORMATION. IF A SWITCH IS CLOSED THEN IT
1060 DJR0   LSR A         ;PRODUCES A ZERO BIT. IF A SWITCH IS OPEN THEN
1070        BCS DJR1      ;IT PRODUCES A ONE BIT. THE JOYSTICK DIR-
1080        INY           ;ECTIONS ARE RIGHT, LEFT, FORWARD, BACKWARD
1090 DJR1   LSR A         ;BIT3=RIGHT, BIT2=LEFT, BIT1=BACKWARD,
1100        BCS DJR2      ;BIT0=FORWARD AND BIT4=FIRE BUTTON.
1110        DEX           ;AT RTS TIME DX AND DY CONTAIN 2'S COMPLIMENT
1120 DJR2   LSR A         ;DIRECTION NUMBERS I.E. $FF=-1, $00=0, $01=1.
1130        BCS DJR3      ;DX=-1 (MOVE RIGHT), DX=1 (MOVE LEFT),
1140        INX           ;DX=0 (NO X CHANGE). DY=-1 (MOVE UP SCREEN),
1150 DJR3   LSR A         ;DY=1 (MOVE DOWN SCREEN), DY=0 (NO Y CHANGE).
1160        STX DX        ;THE FORWARD JOYSTICK POSITION CORRESPONDS
1170        STY DY        ;TO MOVE UP THE SCREEN AND THE BACKWARD
1180        RTS           ;POSITION TO MOVE DOWN SCREEN.
1190 ;
1200 ;AT RTS TIME THE CARRY FLAG CONTAINS THE FIRE BUTTON STATE.
1210 ;IF C=1 THEN BUTTON NOT PRESSED. IF C=0 THEN PRESSED.
1220 ;
1230 .END
```







Normally a 1 i.e. pushing to F gnd's bit 0.

R	L	B	F	X_{10}	Y_{10}	X_{16}	Y_{16}	
0	0	0	0	0	0	00	00	
0	0	0	1	0	1	00	01	
0	0	1	0	0	-1	00	FF	
0	0	1	1	0	0	00	00	
0	1	0	0	1	0	01	00	
✓ 0	1	0	1	1	1	01	01	
✓ 0	1	1	0	1	-1	01	FF	
✓ 0	1	1	1	1	0	01	00	
1	0	0	0	-1	0	FF	00	
✓ 1	0	0	1	-1	1	FF	01	
✓ 1	0	1	0	-1	-1	FF	FF	
✓ 1	0	1	1	-1	0	FF	00	
1	1	0	0	0	0	00	00	
✓ 1	1	0	1	0	1	00	01	
✓ 1	1	1	0	0	-1	00	FF	
✓ 1	1	1	1	0	0	00	00	

Note :- FF ≡ -1

R	L	B	F	X_{10}	Y_{10}	X_{16}	Y_{16}	
0	1	A	A	1	0	01	00	0
0	1	0	1	1	1	01	01	1
A	A	0	1	0	1	00	01	2
1	0	0	1	-1	1	FF	01	3
1	0	A	A	-1	0	FF	00	4
1	0	1	0	-1	-1	FF	FF	5
A	A	1	0	0	-1	00	FF	6
0	1	1	0	1	-1	01	FF	7
A	A	B	B	0	0	00	00	8

A ∈ {0, 1} , B ∈ {0, 1}

Digital Joystick Read Routine

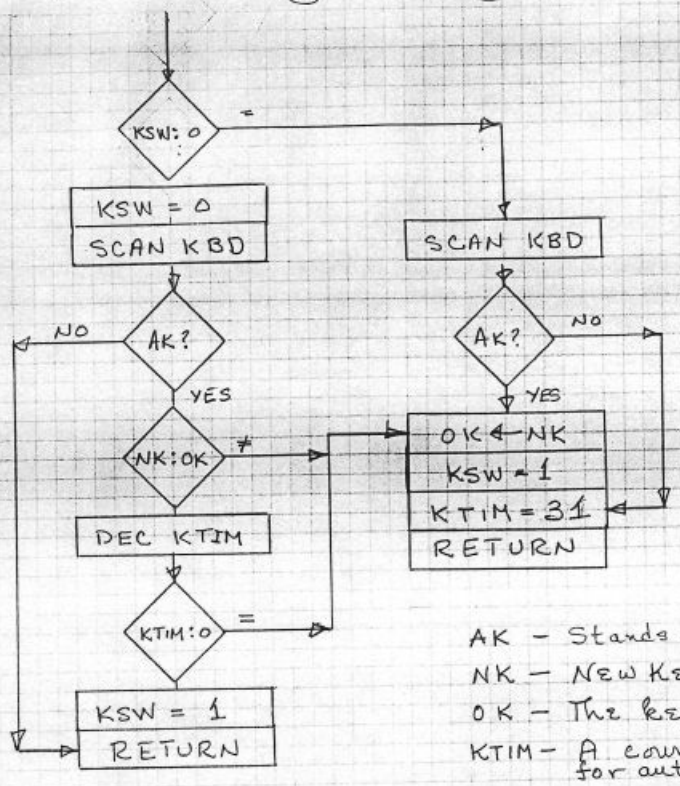
KBD.6/30

READY.

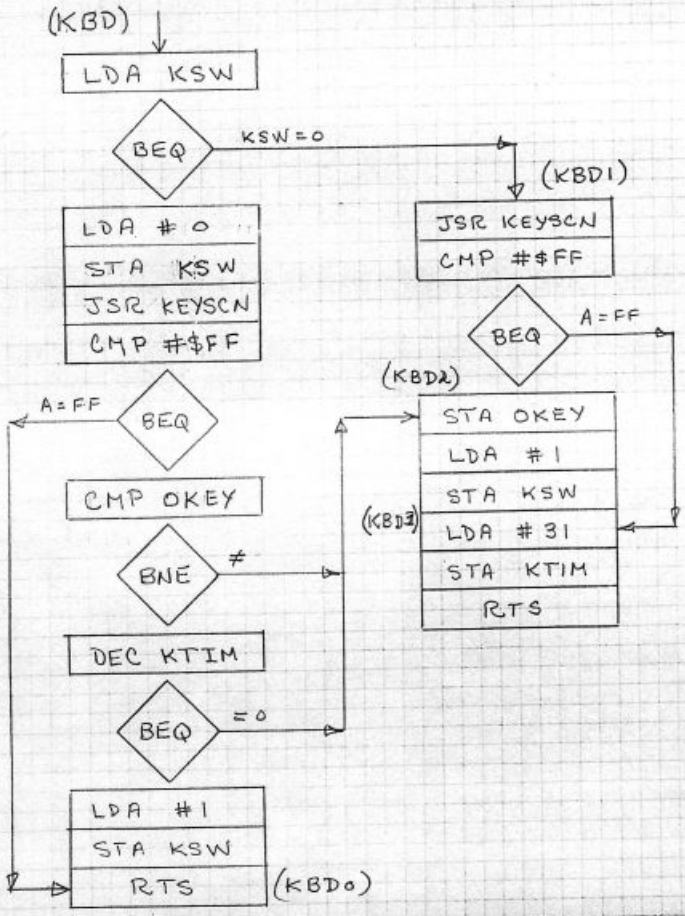
```
.PAGE
1000 KBD     LDA KSW            ;THIS ROUTINE HANDLES AUTO REPEAT
1010         BEQ KBD1           ;OF KEYS HELD DOWN FOR MORE THAN
1020         LDA #0             ;.5 SECONDS. IT SHOULD NOT BE CALLED
1030         STA KSW            ;MORE THAN ONCE PER 1/60TH OF A SECOND.
1040         JSR KEYSCN         ;A PROGRAM SWITCH KSW IS EMPLOYED TO
1050         CMP #$FF           ;SEE IF A KEY IS BEING HELD DOWN
1060         BEQ KBD0           ;AND A COUNTER KTIM IS USED TO COUNT
1070         CMP OKEY           ;FRAMES (1/60THS OF A SECOND). BOTH
1080         BNE KBD2           ;SHOULD BE CLEARED PRIOR TO FIRST USE.
1090         DEC KTIM           ;THE USER SHOULD TAKE CARE TO PREVENT
1100         BEQ KBD2           ;MULTIPLE MULTIPLE KEY DETECTION BY
1110         LDA #1             ;CALLING KBD ONLY ONCE PER FRAME
1120         STA KSW            ;THIS WILL RESOLVE KEY BOUNCE PROBLEMS.
1130 KBD0    RTS
1140 KBD1    JSR KEYSCN
1150         CMP #$FF
1160         BEQ KBD3
1170 KBD2    STA OKEY
1180         LDA #1
1190         STA KSW
1200 KBD3    LDA #31
1210         STA KTIM
1220         RTS
1230 KEYSCN  LDA #$FF           ; KEY SCANNER SUBROUTINE
1240         STA PA
1250         CMP PB
1260         BNE KOUT           ;BUTTON B OR JOYSTICK B (CODE-$FF)
1270         CMP PA
1280         BNE KOUT           ;BUTTON A OR JOYSTICK A (CODE-$FF)
1290         LDA #0
1300         STA PA
1310         LDA #$FF
1320         CMP PB
1330         BEQ KOUT           ;NO KEY DEPRESSED (CODE-$FF)
1340         LDX #7             ;MAIN SCANNING ALGORITHM
1350 KS0     LDY #7
1360         LDA KSTBL,X        ;KSTBL IS AN AUXILIARY TABLE
1370         STA PA             ;OF 8 BYTES EACH HAVING ONLY
1380 KS1     LDA PB             ;ONE ZERO BIT. EACH BYTE IS
1390         CMP KSTBL,Y        ;USED TO ENABLE A KEY MATRIX ROW
1400         BEQ KS2            ;AND LOOK FOR A KEY DOWN ON A
1410         DEY                ;COLUMN BASIS. THE COMBINATION
1420         BPL KS1            ;PRODUCES 64 ROW/COLUMN INTER-
1430         DEX                ;SECTIONS THAT CORRESPOND TO
1440         BPL KS0            ;THE PHYSICAL KEYBOARD
1450         TXA                ;NO LEGAL KEY FOUND DURING SCAN (CODE-$FF)
1460 KOUT    RTS
1470 KS2     TXA                ;THIS PART OF THE ROUTINE TAKES
1480         ASL A              ;THE ROW NUMBER (X) AND THE COLUMN
1490         ASL A              ;NUMBER (Y) AND PRODUCES A ONE BYTE
1500         ASL A              ;CODE IN THE ACCUMULATOR. THE MOST
1510         ASL A              ;SIGNIFICANT NYBBLE OF THE ACCUMULATOR
1520         STY TY             ;IS THE ROW NUMBER AND THE LEAST
1530         ORA TY             ;SIGNIFICANT NYBBLE IS THE COLUMN
1540         RTS                ;NUMBER
1550;KSTBL   .BYTE $FE,$FD,$FB,$F7,$EF,$DF,$BF,$7F
1560 .END
```

READY.

Logical Keyboard Scanner



AK – Stands for any key (down)
NK – New Key i.e. the key currently being pressed
OK – The key before the current new key
KTIM – A counter decremented once/frame used for auto repeat.
KSW – Keyboard program switch

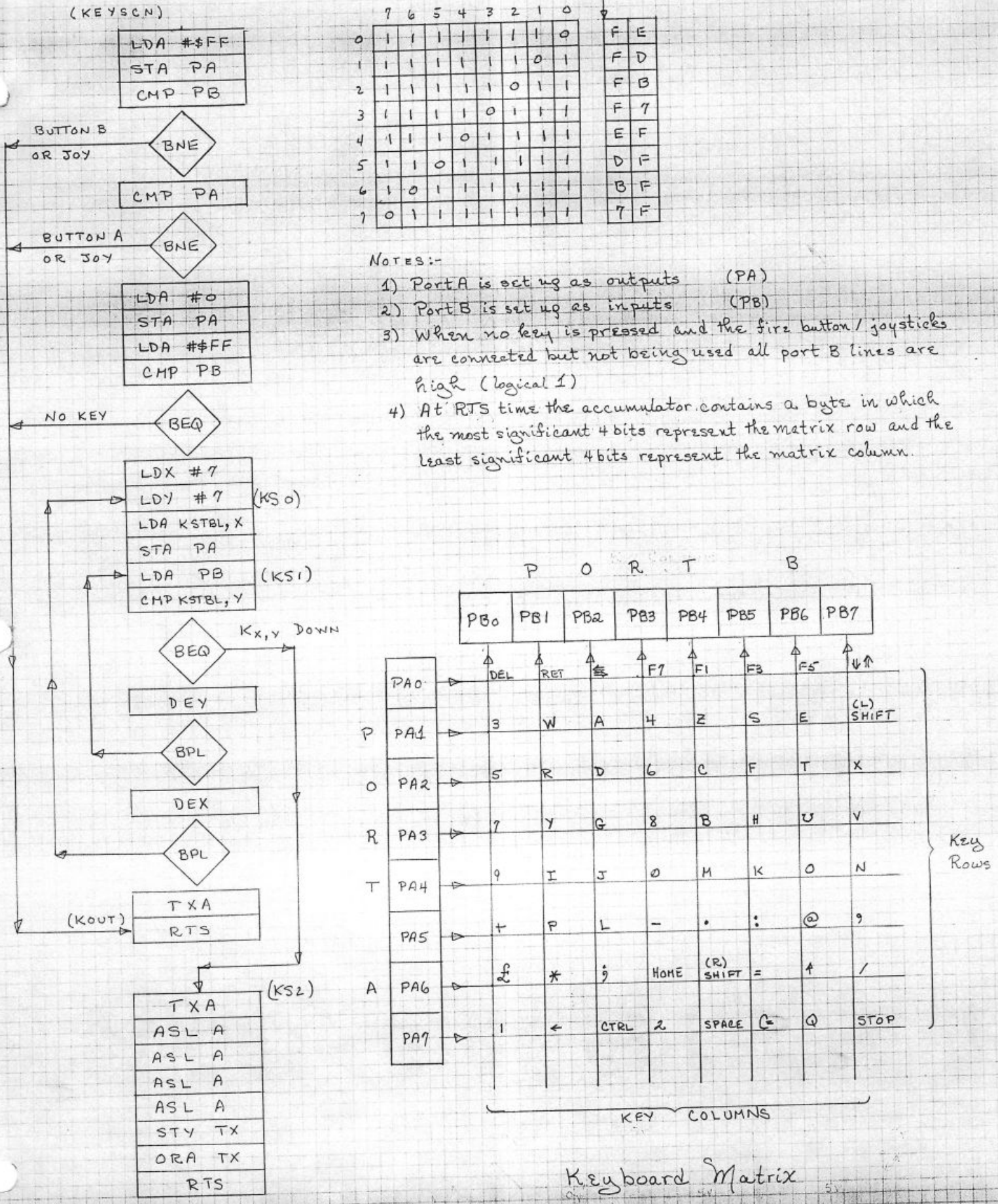


NOTES:-

1) The subroutine KEYSCN is found on the next page.
2) The variable NK is redundant and is replaced by leaving the key code in ACC after KEYSCN.
3) ACC = FF (hex) ⇔ no key recognized.
4) If ACC ≠ FF then the MSN of A is the key matrix ROW and the LSN of A is the COLUMN.
5) It is presumed that KBD is called once per 1/60 sec
6) It is also presumed that Port A is set up as outputs and Port B as inputs prior to calling KBD

WARNING:-

If you wish to change this routine be sure you consider the pathological behavior of the keyboards and users. For examples — keys bounce — more than 1 key pressed at a time — a key is held down — a fire button is pressed — a joystick contact is made — etc


(KEYSCN)
LDA #$FF
STA PA
CMP PB
BUTTON B OR JOY
BNE
CMP PA
BUTTON A OR JOY
BNE
LDA #0
STA PA
LDA #$FF
CMP PB
NO KEY
BEQ
LDX #7
LDY #7
(KS0)
LDA KSTBL,X
STA PA
LDA PB
(KS1)
CMP KSTBL,Y
BEQ
KX,Y DOWN
DEY
BPL
DEX
BPL
TXA
RTS
(KOUT)
(KS2)
TXA
ASL A
ASL A
ASL A
ASL A
STY TX
ORA TX
RTS
7 6 5 4 3 2 1 0
0 1 1 1 1 1 1 1 0
1 1 1 1 1 1 1 0 1
2 1 1 1 1 1 1 0 1 1
3 1 1 1 1 1 0 1 1 1
4 1 1 1 1 0 1 1 1 1
5 1 1 1 0 1 1 1 1 1
6 1 0 1 1 1 1 1 1 1
7 0 1 1 1 1 1 1 1 1
KSTBL
0 F E
1 F D
2 F B
3 F 7
4 E F
5 D F
6 B F
7 7 F
NOTES:-
1) Port A is set up as outputs (PA)
2) Port B is set up as inputs (PB)
3) When no key is pressed and the fire button / joysticks are connected but not being used all port B lines are high (logical 1)
4) At RTS time the accumulator contains a byte in which the most significant 4 bits represent the matrix row and the least significant 4 bits represent the matrix column.
PORT B
PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7
PA0 DEL RET ← F7 F1 F3 F5 ↓↑
PA1 3 W A 4 Z S E (L) SHIFT
PA2 5 R D 6 C F T X
PA3 7 Y G 8 B H U V
PA4 9 I J 0 M K O N
PA5 + P L - . : @ ,
PA6 £ * ; HOME (R) SHIFT = ↑ /
PA7 1 ← CTRL 2 SPACE C= Q STOP
PORT A
Key Rows
KEY COLUMNS

Keyboard Matrix

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